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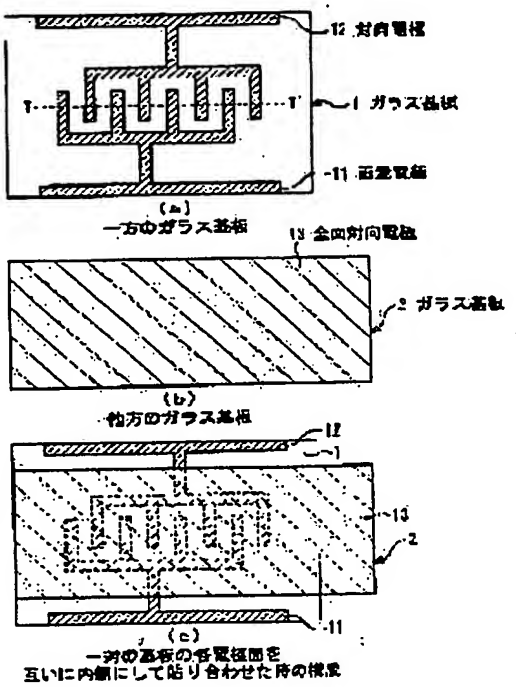
(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a liquid crystal display device having a liquid crystal layer consisting of a cholesteric liquid crystal or chiral nematic liquid crystal and having high display quality which suppresses generation of hysterisys and which makes low-voltage driving possible.
SOLUTION: A liquid crystal cell is produced by preparing a substrate 1 having pixel electrodes 11 and counter electrodes 12 each patterned into a comb-like form on the surface of the substrate and disposed facing each other with an equal gap from each other, preparing a substrate 2 having an all-face counter electrode on the surface, and holding a liquid crystal layer 3 consisting of a cholesteric liquid crystal or chiral nematic liquid crystal between the faces of the substrates where the electrodes are formed.



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CLAIMS

[Claim(s)]
[Claim 1] It is the liquid crystal display which comes to pinch the liquid crystal layer which consists of cholesteric liquid crystal or a chiral pneumatic liquid crystal between the substrates of the pair which counters. In said one substrate front face, the 1st electrode corresponding to each pixel is arranged at said substrate front face of another side so that the 2nd electrode may counter mutually through said liquid crystal layer. Said 1st electrode The liquid crystal display characterized by impressing a predetermined electrical potential difference between said pixel electrodes and said counterelectrodes while having the counterelectrode put side by side so that it might counter in the same field as a pixel electrode and the pixel electrode concerned, being constituted and impressing a predetermined electrical potential difference between said pixel electrode and said 2nd electrode.
[Claim 2] the distance between said pixel electrodes and said counterelectrodes — 6 micrometers or less — it is -- and the thickness of said liquid crystal layer -- it can twist -- a ratio with a pitch — the liquid crystal display according to claim 1 characterized by d/p being 14 or less.
[Claim 3] the thickness of said liquid crystal layer -- 5 micrometers or less -- it is -- and the thickness of said liquid crystal layer — it can twist — the ratio of a pitch — the liquid crystal display according to claim 1 characterized by d/p being two or less.
[Claim 4] a torsion pitch — difference — the liquid crystal display according to claim 1 with which the laminating of said two or more liquid crystal layers which consist of liquid crystal is carried out through said substrate, and said each liquid crystal layer is characterized by coming to allot said 2nd electrode to the field of another side while said 1st electrode is arranged on one field.
[Claim 5] said liquid crystal layer — a torsion pitch — difference — the liquid crystal display according to claim 1 characterized by coming to be enclosed with the field divided with the shelter so that the liquid crystal of a lot might correspond to each pixel, and a picture element being constituted by the pixel group corresponding to the liquid crystal of said lot.
[Claim 6] the direction of torsion -- difference -- the liquid crystal display according to claim 1 with which the laminating of said two sorts which consist of liquid crystal of liquid crystal layers is carried out through said substrate, and said each liquid crystal layer is characterized by coming to allot said 2nd electrode to the field of another side while said 1st electrode is arranged on one field.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the liquid crystal display equipped with the liquid crystal layer which consists of cholesteric liquid crystal or a chiral pneumatic liquid crystal about a liquid crystal display.
[0002]
[Description of the Prior Art] Generally, cholesteric liquid crystal has the various descriptions, such as light scattering and selective reflection, as a property based on the distorted molecular arrangement. As a liquid crystal cell of the liquid crystal display using this cholesteric liquid crystal, as shown in drawing 22 , there are some which have the structure where the liquid crystal layer 105 of cholesteric liquid crystal was pinched between the substrates 101,102 of the pair which has an electrode 103,104 on a front face, respectively. This liquid crystal display is made to transform the orientation of the liquid crystal layer 105 by impressing an electrical potential difference between the electrodes 103,104 which counter, and, thereby, performs image display. The method which controls a dispersion condition and a transparence condition by the electrical potential difference, and the method which controls red, the selective reflection condition of a green or blue light, and a transparence condition by the electrical potential difference are shown in means of displaying. By any method, in order to acquire a good display property, it is necessary to enlarge angle of torsion of the cholesteric-liquid-crystal molecule of the liquid crystal layer 105.
[0003]
[Problem(s) to be Solved by the Invention] However, generally, in the liquid crystal display using cholesteric liquid crystal, when angle of torsion becomes 300 degrees or more, a hysteresis occurs. When this hysteresis exists, in order that the orientation condition at the time of electrical-potential-difference impression may be dependent on the orientation condition before electrical-potential-difference impression, there is a problem that good image display cannot be obtained. A hysteresis tends to increase, so that angle of torsion becomes large.
[0004] Then, the purpose of this invention is offering the high liquid crystal display of the display grace which inhibits generating of a hysteresis and enables the drive by the low battery about the liquid crystal display equipped with the liquid crystal layer which consists of cholesteric liquid crystal or a chiral pneumatic liquid crystal.
[0005]
[Means for Solving the Problem] The liquid crystal display of this invention is a thing which comes to pinch the liquid crystal layer which consists of cholesteric liquid crystal or a chiral pneumatic liquid crystal between the substrates of the pair which counters. In said one substrate front face, the 1st electrode corresponding to each pixel is arranged at said substrate front face of another side so that the 2nd electrode may counter mutually through said liquid crystal layer. Said 1st electrode While having the counterelectrode put side by side so that it might counter in the same field as a pixel electrode and the pixel electrode concerned, being constituted and impressing a predetermined electrical potential difference between said pixel electrode and said 2nd electrode, a predetermined electrical potential difference is impressed between said pixel electrodes and said counterelectrodes.
[0006] 1 voice of the liquid crystal display of this invention -- like -- setting -- the distance between said pixel electrodes and said counterelectrodes -- 6 micrometers or less -- it is -- and the thickness of said liquid crystal layer -- it can twist -- a ratio with a pitch -- d/p is 14 or less.
[0007] 1 voice of the liquid crystal display of this invention -- like -- setting -- the thickness of

said liquid crystal layer — it can twist — a ratio with a pitch — d/p is four or less.
[0008] 1 voice of the liquid crystal display of this invention — like — setting — the thickness of said liquid crystal layer — 5 micrometers or less — it is — and the thickness of said liquid crystal layer — it can twist — the ratio of a pitch — d/p is two or less.
[0009] 1 voice of the liquid crystal display of this invention — like — setting — a torsion pitch — difference — the laminating of said two or more liquid crystal layers which consist of liquid crystal is carried out through said substrate, and while said 1st electrode is arranged on one field, as for said each liquid crystal layer, it comes to allot said 2nd electrode to the field of another side
[0010] 1 voice of the liquid crystal display of this invention — like — setting — said liquid crystal layer — a torsion pitch — difference — it comes to be enclosed with the field divided with the shelter so that the liquid crystal of a lot might correspond to each pixel, and a picture element is constituted by the pixel group corresponding to the liquid crystal of said lot.
[0011] 1 voice of the liquid crystal display of this invention — like — setting — the direction of torsion — difference — the laminating of said two sorts which consist of liquid crystal of liquid crystal layers is carried out through said substrate, and while said 1st electrode is arranged on one field, as for said each liquid crystal layer, it comes to allot said 2nd electrode to the field of another side
[0012]
[Function] In the liquid crystal display of this invention, while a pixel electrode and this, and the counterelectrode put side by side are formed in one substrate front face as the 1st electrode, and the 2nd electrode is prepared in the substrate front face of another side which counters and impressing a predetermined electrical potential difference between the pixel electrode and the 2nd electrode which are the component of the 1st electrode, a predetermined electrical potential difference is impressed between a pixel electrode and a counterelectrode. That is, in the liquid crystal layer pinched by the substrate of a pair, since control by the predetermined electrical potential difference is performed to each of the field inboard which intersects perpendicularly with the thickness direction and this, generating of a hysteresis is efficiently inhibited by two sorts of armature-voltage control from which these directions differ, and a high-definition display image is realized.
[0013]
[Embodiment of the Invention] It explains to a detail, referring to a drawing hereafter about the concrete operation gestalt which applied this invention. Drawing 1 is the outline top view showing the main configurations of the image display device of this operation gestalt, and drawing 2 is an outline sectional view in alignment with broken-line I-I' of the image display device of drawing 1 .
[0014] The image display device of this operation gestalt is equipped with the liquid crystal cell which has it come to pinch the liquid crystal layer 3 which consists of cholesteric liquid crystal or a chiral pneumatic liquid crystal with the glass substrates 1 and 2 of a pair with which the electrode was respectively formed in the front face, and is constituted.
[0015] As shown in drawing 1 (a), a glass substrate 1 has the 1st electrode which the pixel electrode 11 and a counterelectrode 12 are put side by side on a front face (opposed face with a glass substrate 2), and becomes, and is constituted. Patterning of the pixel electrode 11 and the counterelectrode 12 is respectively carried out to a ctenidium configuration, and they are formed so that it may counter at equal intervals mutually. Thus, in the 1st constituted electrode, it will be equivalent to 1 pixel by the part of the pixel electrode 11 which carries out phase opposite, and a counterelectrode 12 (that is, the pixel electrode 11 equivalent to 3 pixels is shown by the example of drawing 2 .), and both non-illustrated thin film transistors (TFT:Thin Film Transistor) will be prepared for every pixel.
[0016] On the other hand, as shown in drawing 1 (b), the 2nd electrode (whole surface counterelectrode 13) is formed, and the glass substrate 2 is constituted so that the surface (opposed face with a glass substrate 1) whole surface may be covered.
[0017] And as shown in drawing 1 (c) and drawing 2 , the liquid crystal layer 3 is pinched with glass substrates 1 and 2 so that the 1st electrode and 2nd electrode may be made to counter, a predetermined power source is connected to each electrode, and an image display device is

constituted.
[0018] Here, the principle of operation of the image display device of this operation gestalt is explained. Drawing 3 is the outline sectional view showing an example by which a pulse voltage is impressed to each electrode of an image display device from a power source E. A counterelectrode 12 and the whole surface counterelectrode 13 are made into same electric potential, and a predetermined electrical potential difference is impressed to this image display device between the pixel electrode 11 and the whole surface counterelectrode 13 and between the pixel electrode 11 and a counterelectrode 12.
[0019] Like the above, by impressing a predetermined electrical potential difference to each of the field inboard which intersects perpendicularly with the liquid crystal layer 3 with the thickness direction and this, as shown in drawing 4 , torsion is cleared from the liquid crystal molecule on the pixel electrode 11. The actuation by which the hysteresis was decreased and stabilized is obtained by being able to twist with the distance (inter-electrode spare time L) of the pixel electrode 11 and a counterelectrode 12, thickness [of the liquid crystal layer 3] d, and thickness d, and adjusting a ratio (d/p) with a pitch p to a ** value, as shown below.
[0020] - Example of an experiment - The examples of many experiment which investigated thickness [of an electrical-potential-difference permeability property, the inter-electrode spare time L, and a liquid crystal layer] d and the correlation of the value of d/p and a hysteresis are shown concretely.
[0021] On each front face of a glass substrate 2 in which the glass substrate 1 and the whole surface counterelectrode 13 with which the pixel electrode 11 and the counterelectrode 12 were formed in the front face were formed, as orientation film Form the trade name AL3046 which is the parallel orientation film by Japan Synthetic Rubber Co., Ltd. with a spin coat, and rubbing processing is performed. The liquid crystal layer 3 which consists of cholesteric liquid crystal (Merck what mixed trade name CB-15 which are chiral company material to the trade name TL 202 which is shrine liquid crystal, and adjusted the pitch) with these glass substrates 1 and 2 is pinched, and a liquid crystal cell is produced. Said monograph affair for forming the liquid crystal cell concerned is named generically, and it considers as Conditions A.
[0022] (Example 1 of an experiment) An electrical-potential-difference permeability property (V-T property) is measured first. In this example, it adds to Conditions A, and they are the pixel electrode width of face W1 and the counterelectrode width of face W2 about the pixel electrode 11 and a counterelectrode 12. And when the inter-electrode spare time L is defined like drawing 5 , as shown in drawing 6 The pixel electrode width of face W1 and counterelectrode width of face W2 And the glass substrate 1 formed so that each value of the inter-electrode spare time L might become equal is used. The pigmentum nigrum was mixed in liquid crystal so that change of a hysteresis might be in sight, the liquid crystal cell was produced so that the thickness of the liquid crystal layer 3 might be set to 6 micrometers and d/p might be set to 2.26, and the electrical-potential-difference permeability property (V-T property) was measured. Here, the conventional liquid crystal cell as shown in drawing 22 was created as an example of a comparison of this example, and it measured similarly.
[0023] A measurement result is shown in drawing 7 . Thus, although the big hysteresis appeared in the conventional example, to it, by this example, a hysteresis was hardly seen but reduction of a large hysteresis has been checked.
[0024] In this example, it adds to Conditions A. (Experiment 2) The pixel electrode 11 and a counterelectrode 12 The pixel electrode width of face W1 and counterelectrode width of face W2 And it is formed so that each value of the inter-electrode spare time L may become equal. Using each glass substrate 1 with which inter-electrode spare time L was set to 4 micrometers, 6 micrometers, 10 micrometers, 15 micrometers, and 25 micrometers, d/p was changed, the liquid crystal cell was produced, respectively, and the relation between d/p and a hysteresis band was investigated. However, a hysteresis band is defined as the maximum width of a hysteresis. The conventional liquid crystal cell as shown in drawing 22 was made into the example of a comparison like the experiment 1 also here.
[0025] A measurement result is shown in drawing 8 . If the value of d/p becomes large, a hysteresis will become large, in order that the liquid crystal molecule on the pixel electrode 11

may deform perpendicularly to a glass substrate 1 and may begin to present complicated orientation deformation. It turns out that it is not based on the inter-electrode spare time L when d/p is 14 or less and the inter-electrode spare time L is 6 micrometers or less, but it has specifically become a hysteresis smaller than the conventional example when d/p is four or less. The result which thickness d of the liquid crystal layer 3 is 5 micrometers or less, and a hysteresis has hardly generated especially when d/p is two or less was obtained. The relation of the inter-electrode spare time L and d/p which can check reduction of a hysteresis comes to be shown in the following table 1.

[0026]

[Table 1]

電極間隙L	d／p
4 μm	16以下
6 μm	14以下
10 μm	4以下
15 μm	4以下
25 μm	4以下

[0027] In addition, the improvement of a hysteresis was found when the measurement same also about the liquid crystal cell using the perpendicular orientation film as experiments 1 and 2 was tried.

[0028] In this example, it adds to Conditions A. (Experiment 3) The pixel electrode 11 and a counterelectrode 12 The pixel electrode width of face W1 and counterelectrode width of face W2 And the liquid crystal cell which set inter-electrode spare time L to 4 micrometers using the glass substrate 1 formed so that each value of the inter-electrode spare time L might become equal (cel a), As an example of a comparison, the liquid crystal cell (cel b) which does not have the whole surface counterelectrode 13 was used for the glass substrate 2 by said liquid crystal cell as shown in drawing 9 . It asked for the driver voltage to which permeability becomes almost fixed from the electrical-potential-difference permeability property which measured and measured the electrical-potential-difference permeability property using these liquid crystal cells.

[0029] A measurement result is shown in drawing 10 . Thus, as compared with Cel b, a hysteresis is small for whether your being Haruka, and, as for Cel a, it turns out that driver voltage can be made low.

[0030] In this example, it adds to Conditions A. (Experiment 4) The pixel electrode 11 and a counterelectrode 12 When the glass substrate 1 formed so that it might be set to pixel electrode width-of-face W1= counterelectrode width-of-face W2 != inter-electrode spare time L is used (drawing 11 (a)), When the glass substrate 1 formed so that it might become the pixel electrode width-of-face W1 = inter-electrode spare time L!= counterelectrode width of face W2 (even the pixel electrode width-of-face W2 = inter-electrode spare time L!= counterelectrode width of face W1 is the same) is used (drawing 11 (b)), The pixel electrode width of face W1 and counterelectrode width of face W2 And experiments 1-3 were conducted about each at the time of considering as the value from which the inter-electrode spare time L all differs (drawing 11 (c)). Consequently, in any case, the improvement of a hysteresis was found.

[0031] - Explain many modifications of the image display device of this operation gestalt below modification -. Here, a same sign is described about the same configuration member as the image display device of this operation gestalt, and explanation is omitted.
[0032] (Modification 1) Here, as shown in drawing 12 , the image display device equipped with the liquid crystal cell which made the crosswise cross-section configuration of the pixel electrode 11 and a counterelectrode 12 the letter of a projection is indicated. A projection configuration can use a thing like illustration, the thing which chose the taper angle as arbitration, and the thing which consisted of curved surfaces. Also in this case, an extensive improvement of a hysteresis is found like this operation gestalt.
[0033] (Modification 2) Here, as shown in drawing 13 , the image display device equipped with the liquid crystal cell which comes to pinch the liquid crystal layer 3 of cholesteric liquid crystal using the glass substrate 1 with which the pixel electrode 11 and a counterelectrode 12 are formed from aluminum (aluminum), and become, and the glass substrate 2 to which it comes to form the whole surface counterelectrode 13 with a transparent electrode (ITO) is indicated. When the image display property was observed using this liquid crystal cell, it checked that the light reflected with the pixel electrode 11 and counterelectrode 12 which are an aluminum electrode could also be used effectively, and could obtain a good display.
[0034] Although aluminum was used for the pixel electrode 11 and the counterelectrode 12 as an ingredient in both these examples, it is also possible to use a metal with a high silver (Ag) reflection factor or to use a metal which is different with the pixel electrode 11 and a counterelectrode 12.
[0035] (Modification 3) Here, as shown in drawing 14 , the image display device equipped with the liquid crystal cell which comes to pinch the liquid crystal layer 3 of cholesteric liquid crystal using the silicon substrate 21 in which the pixel electrode 11 and a counterelectrode 12 are formed with a transparent electrode, and which they become, and the glass substrate 2 to which it comes to form the whole surface counterelectrode 13 with a transparent electrode is indicated. When the image display property was observed using this liquid crystal cell, it checked that the light reflected by the silicon substrate 21 could also be used effectively, and could obtain a good display.
[0036] (Modification 4) Here, as shown in drawing 15 , the image display device equipped with the liquid crystal cell which comes to pinch the liquid crystal layer 3 of cholesteric liquid crystal using the glass substrate 1 with which the pixel electrode 11 and a counterelectrode 12 are formed with a transparent electrode, and become, and the glass substrate 2 with which it comes to form the whole surface counterelectrode 13 in Cr layer is indicated. According to this liquid crystal cell, Cr layer functions as a light absorption layer, and since the light which reached Cr layer is absorbed, it can acquire a good black condition.
[0037] (Modification 5) Here, as shown in drawing 16 , the image display device equipped with the liquid crystal cell which comes to pinch the liquid crystal layer 3 of cholesteric liquid crystal using the glass substrate 1 with which the pixel electrode 11 and a counterelectrode 12 are formed with a transparent electrode, and become, and the glass substrate 2 which it comes to consider as the laminating configuration of black light absorption layer 13a whose whole surface counterelectrode 13 is Cr layer, and transparent electrode 13b is indicated. According to this liquid crystal cell, black light absorption layer 13a functions as a light absorption layer, and since the light which reached black light absorption layer 13a is absorbed, it can acquire a good black condition.
[0038] (Modification 6) Here, as shown in drawing 17 , the liquid crystal cell which comes to pinch the liquid crystal layer 3 of cholesteric liquid crystal using the silicon substrate 1 in which the pixel electrode 11 and a counterelectrode 12 are formed with a transparent electrode, and which they become, and the glass substrate 2 to which it comes to form the whole surface counterelectrode 13 with a transparent electrode is constituted, and the image display device which comes to stick the black light absorption plate 22 on the tooth back of a liquid crystal cell is indicated. According to this liquid crystal cell, since the light which reached the black light absorption plate 22 is absorbed, it can acquire a good black condition.
[0039] (Modification 7) here, it is shown in drawing 18 -- as -- a torsion pitch -- difference --

the image display device equipped with each liquid crystal cell which comes to pinch the three-layer liquid crystal layers 3a, 3b, and 3c which consist of liquid crystal through glass substrates 31-34, respectively is indicated. In this liquid crystal cell, each electrode is formed in glass substrates 31-34 so that the 1st electrode (the pixel electrode 11 and counterelectrode 12) may consist in one field of each liquid crystal layers 3a, 3b, and 3c and the 2nd electrode (whole surface counterelectrode 13) may consist in the field of another side. That is, in one front face of the 2nd electrode and glass substrates 32 and 33, the 2nd electrode is formed in the front face of the 1st electrode and another side by one front face (liquid crystal layer 3a side) of a glass substrate 31 at one front face (liquid crystal layer 3c side) of the 1st electrode and a glass substrate 34. And the polarizer of two sheets which made the lower part (front face of another side of a glass substrate 31) of the liquid crystal cell by which the laminating was carried out, and a polarization shaft cross at right angles as a black light absorption plate 35 is stuck.

[0040] Each electrodes 11-13 are specifically formed from a transparent electrode. The pixel electrode width of face W1, Counterelectrode width of face W2 And the glass substrates 31-34 formed so that each value of the inter-electrode spare time L might become equal are used. A torsion pitch 0.40 micrometers, 0.33 micrometers, Pinch the liquid crystal layers 3a, 3b, and 3c which consist of cholesteric liquid crystal (Merck what could mix and twist trade name CB-15 which are chiral company material to the trade name TL 202 which is shrine liquid crystal, and adjusted the pitch) which is 0.27 micrometers, respectively, and each liquid crystal cell is produced. The laminating of them is carried out.

[0041] It has checked that eight colors of black, white, red, green, blue, yellow, purple, and a light blue were obtained by making each liquid crystal cell drive on an electrical potential difference. In this case, as for each liquid crystal cell equipped with the liquid crystal layers 3a, 3b, and 3c, the large blue and color change by viewing if it is green and the range which selective reflection of the red light can be carried out, and is 0.25 micrometers - 0.30 micrometers, 0.31 micrometers - 0.36 micrometers, and 0.38 micrometers - 0.44 micrometers, respectively was not seen, respectively.

[0042] (Modification 8) the glass substrates 1 and 2 which form the pixel electrode 11, a counterelectrode 12, and the whole surface counterelectrode 13 from a transparent electrode, respectively, and become here as shown in drawing 19 -- using -- between the glass substrate 1 concerned and 2 -- it can twist -- a pitch -- difference -- three sorts of liquid crystal layers 3d, 3e, and 3f which consist of liquid crystal molecules are formed repeatedly, a liquid crystal cell is constituted, and the image display device which comes to stick the black light absorption plate 42 on a cel tooth back is indicated. In this liquid crystal cell, said each liquid crystal is enclosed with the field divided with the shelter 41 for preventing mixing of liquid crystal, it corresponds for every pixel, and one [liquid crystal layers / 3d, 3e, and 3f] is prepared. In this case, a picture element consists of pixel groups of the lot corresponding to the liquid crystal layers 3d, 3e, and 3f, and eight colors of black, white, red, green, blue, yellow, purple, and a light blue are obtained by carrying out the electrical-potential-difference drive of the liquid crystal layer corresponding to each pixel.

[0043] Each electrodes 11-13 are formed from a transparent electrode, and, specifically, they are the pixel electrode width of face W1 and the counterelectrode width of face W2. And the liquid crystal layers 3d, 3e, and 3f which a torsion pitch becomes from the cholesteric liquid crystal which is 0.27 micrometers, 0.33 micrometers, and 0.40 micrometers are allotted for every pixel using the glass substrates 1 and 2 formed so that each value of the inter-electrode spare time L might become equal, and a liquid crystal cell is produced.

[0044] (Modification 9) here, it is shown in drawing 20 -- as -- the direction of torsion -- difference -- that is, the image display device equipped with each liquid crystal cell which comes to pinch 3h of liquid crystal layers which consist of liquid crystal of 3g of liquid crystal layers which consist of liquid crystal of left hand, and right hand through glass substrates 51-53, respectively is indicated. In this liquid crystal cell, each electrode is formed in glass substrates 51-53 so that the 1st electrode (the pixel electrode 11 and counterelectrode 12) may consist in one each liquid crystal layers [3g and 3h] field and the 2nd electrode (whole surface counterelectrode 13) may consist in the field of another side. That is, in one front face of the

2nd electrode and a glass substrate 52, the 2nd electrode is formed in the front face of the 1st electrode and another side by one front face of a glass substrate 51 at one front face of the 1st electrode and a glass substrate 53. And the black light absorption plate 54 is stuck on the tooth back of the liquid crystal cell by which the laminating was carried out.
[0045] Specifically, it is Merck as right hand cholesteric liquid crystal. It is Merck as what mixed trade name CB-15 which are chiral company material to the trade name TL 202 which is shrine liquid crystal, and cholesteric liquid crystal of left hand. The laminating of what added the trade name Ys which is chiral company material was carried out to the trade name TL 202 which is shrine liquid crystal, it could twist so that selective reflection light with green all might be obtained, and the pitch was adjusted to 0.34 micrometers. As a result of observing the liquid crystal panel which carried out the laminating, it checked that a bright display was obtained as compared with the liquid crystal panel of a monolayer.
[0046] (Modification 10) As shown in drawing 21 , the image display device which the forward-scattering plate 61 sticks on a front face, the black light absorption plate 62 sticks on a tooth back, and it comes to unite is illustrated using the same liquid crystal panel as this operation gestalt illustrated to drawing 2 . As a result of observing the display image of this liquid crystal panel, when changing an electrical potential difference, it checked that contrast better than the case where there is no forward-scattering plate 61 was acquired.
[0047] Many modes shown below also constitute this invention.
[0048] It is one mode of a liquid crystal display, and is characterized by a torsion pitch being 0.25 micrometers - 0.44 micrometers.
[0049] It is one mode of a liquid crystal display, and is characterized by the distance of the electrode width of face of said pixel electrode or the electrode width of face of a counterelectrode, and said pixel electrode and said counterelectrode differing.
[0050] It is one mode of a liquid crystal display, and is characterized by the width of face of said pixel electrode differing from the width of face of said counterelectrode.
[0051] It is one mode of a liquid crystal display, and is characterized by making each cross-section configuration of said pixel electrode and said counterelectrode into the letter of a projection.
[0052] It is one mode of a liquid crystal display, and is characterized by forming said one electrode of each of said substrate with the metal.
[0053] It is one mode of a liquid crystal display, and is characterized by being formed with the metal with which said pixel electrode and said counterelectrode differ from each other.
[0054] It is one mode of a liquid crystal display, and is characterized by one side of each of said substrate having a light reflex function.
[0055] It is one mode of a liquid crystal display, and is characterized by one side of each of said substrate having a light absorption function.
[0056] It is one mode of a liquid crystal display, and is characterized by forming the light absorption layer between said electrodes and substrates concerned about one side of each of said substrate.
[0057] It is one mode of a liquid crystal display, and is characterized by giving the light absorption layer to one side of each of said substrate outside.
[0058] It is one mode of a liquid crystal display, and is characterized by sticking the scattered plate on one side of each of said substrate.
[0059]
[Effect of the Invention] According to this invention, about the liquid crystal display equipped with the liquid crystal layer which consists of cholesteric liquid crystal or a chiral pneumatic liquid crystal, generating of a hysteresis is inhibited and the high liquid crystal display of the display grace which enables the drive by the low battery is realized.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

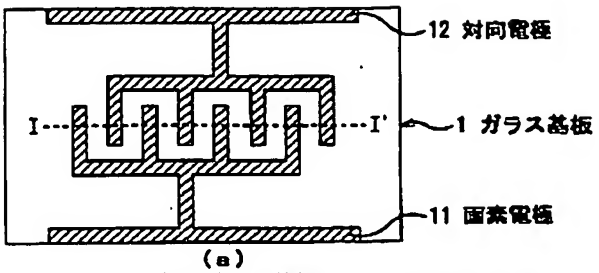
[Brief Description of the Drawings]
[Drawing 1] It is the outline top view showing the main configurations of the image display device of this operation gestalt.
[Drawing 2] It is the outline sectional view showing the main configurations of the image display device of this operation gestalt.
[Drawing 3] It is the outline sectional view showing an example by which a pulse voltage is impressed to each electrode of the image display device of this operation gestalt.
[Drawing 4] It is an outline sectional view for explaining the principle of operation of the image display device of this operation gestalt.
[Drawing 5] About a pixel electrode and a counterelectrode, they are the pixel electrode width of face W1 and the counterelectrode width of face W2. And it is the outline sectional view which defines the inter-electrode spare time L.
[Drawing 6] It is the outline sectional view showing the main configurations of the image display device of the example 1 of an experiment.
[Drawing 7] It is the property Fig. showing the measurement result of an electrical-potential-difference permeability property (V-T property).
[Drawing 8] It is the property Fig. in which being able to twist with thickness d of a liquid crystal layer, and showing the relation between a ratio (d/p) with a pitch p, and a hysteresis band.
[Drawing 9] It is the outline sectional view showing the liquid crystal cell which does not have a whole surface counterelectrode.
[Drawing 10] It is the property Fig. in which being able to twist with thickness d of a liquid crystal layer, and showing the relation between a ratio (d/p) with a pitch p, and a hysteresis band.
[Drawing 11] They are the pixel electrode width of face W1, the counterelectrode width of face W2, and the outline sectional view showing the various liquid crystal cells which changed the relation of the inter-electrode spare time L.
[Drawing 12] It is the outline sectional view showing the main configurations of the image display device of a modification 1.
[Drawing 13] It is the outline sectional view showing the main configurations of the image display device of a modification 2.
[Drawing 14] It is the outline sectional view showing the main configurations of the image display device of a modification 3.
[Drawing 15] It is the outline sectional view showing the main configurations of the image display device of a modification 4.
[Drawing 16] It is the outline sectional view showing the main configurations of the image display device of a modification 5.
[Drawing 17] It is the outline sectional view showing the main configurations of the image display device of a modification 6.
[Drawing 18] It is the outline sectional view showing the main configurations of the image display device of a modification 7.
[Drawing 19] It is the outline sectional view showing the main configurations of the image display device of a modification 8.
[Drawing 20] It is the outline sectional view showing the main configurations of the image display device of a modification 9.

[Drawing 21] It is the outline sectional view showing the main configurations of the image display device of a modification 10.
[Drawing 22] It is the outline sectional view showing the main configurations of the conventional image display device.
[Description of Notations]
1, 2, 31-34, 51-53 Glass substrate
3, 3a-3h Liquid crystal layer
11 Pixel Electrode
12 Counterelectrode
13 Whole Surface Counterelectrode
21 Silicon Substrate
22, 35, 42, 54, 62 Black light absorption plate
41 Shelter
61 Forward-Scattering Plate

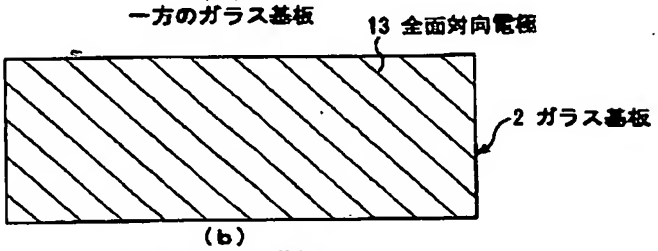
[Translation done.]

DRAWINGS

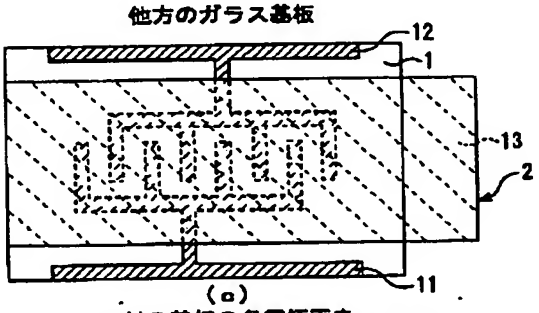
[Drawing 1]



(a)
一方のガラス基板

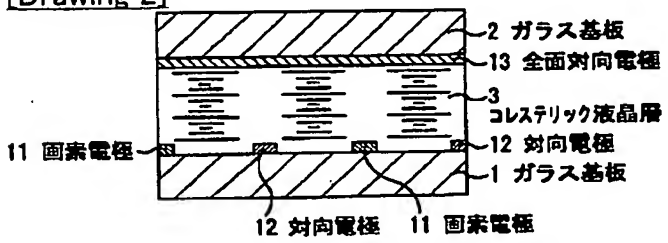


(b)
他方のガラス基板



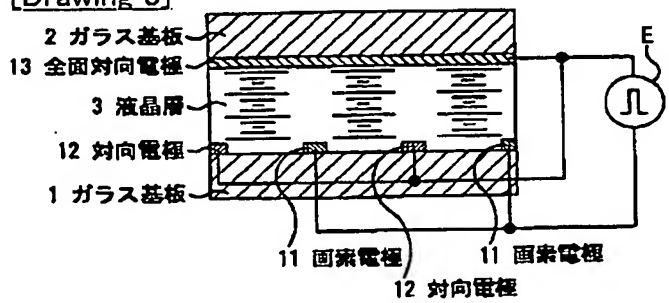
(c)
一対の基板の各電極面を
互いに内側にして貼り合わせた時の構成

[Drawing 2]



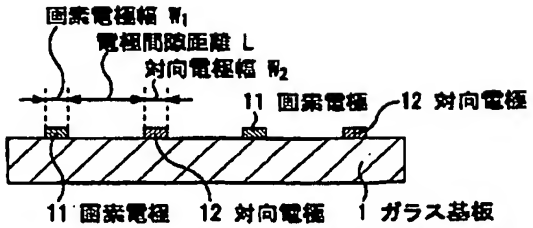
本実施形態の液晶セル

[Drawing 3]



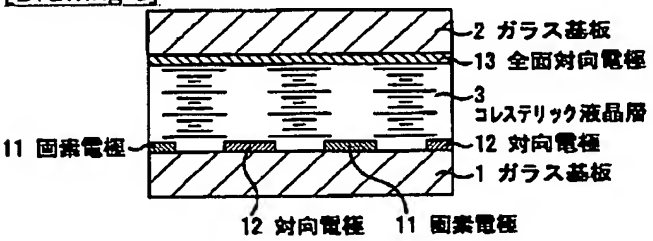
駆動例

[Drawing 5]



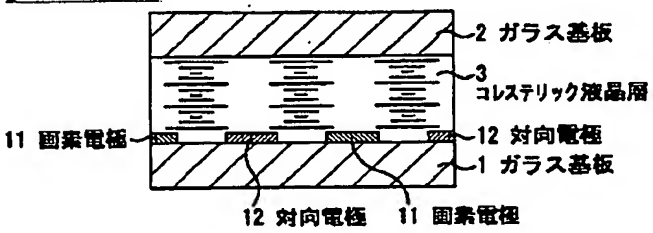
基板表面に画素電極および対向電極を形成したガラス基板

[Drawing 6]



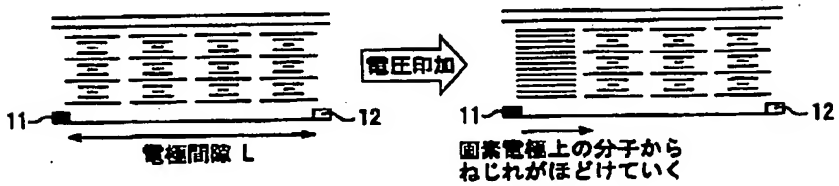
実験例 1

[Drawing 9]

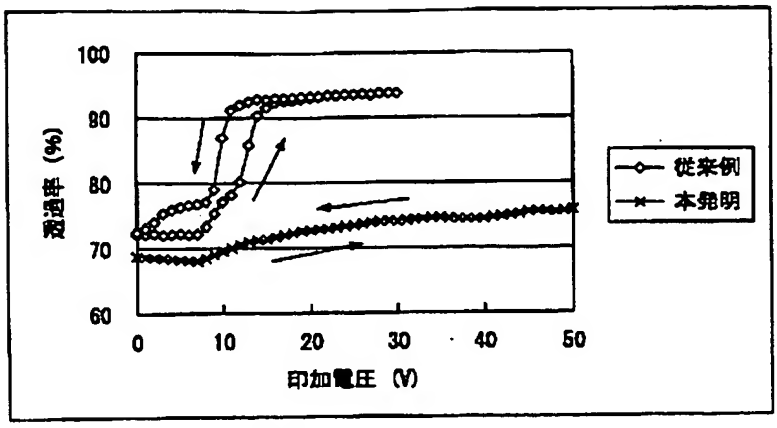


実験例 3

[Drawing 4]

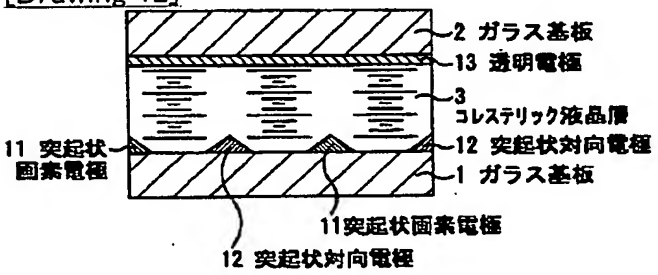


[Drawing 7]



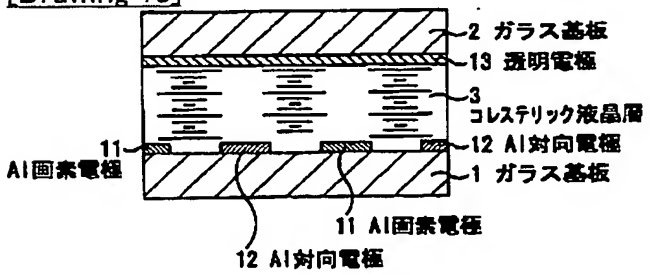
電圧透過率特性(セル厚6μm、d/p=2.26)

[Drawing 12]



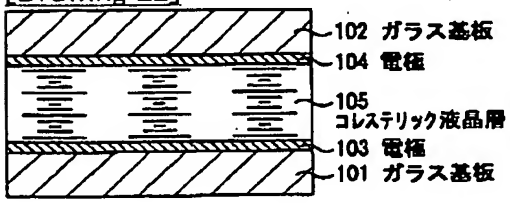
変形例 1

[Drawing 13]



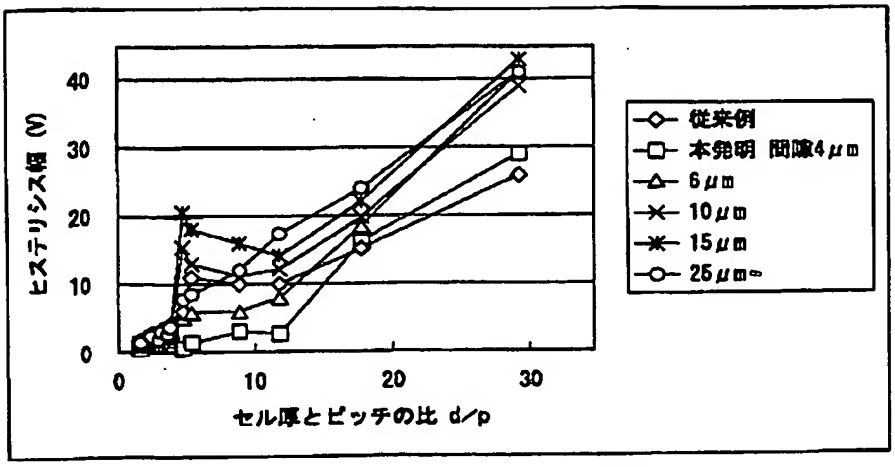
変形例 2

[Drawing 22]



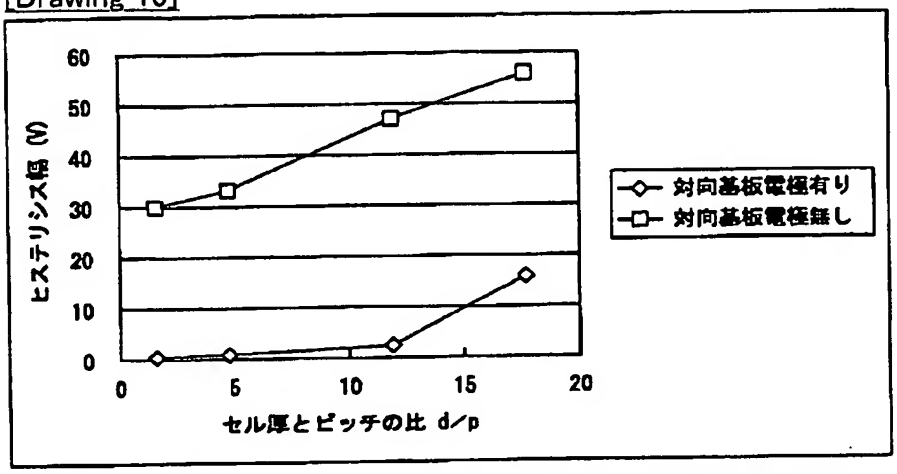
従来例

[Drawing 8]



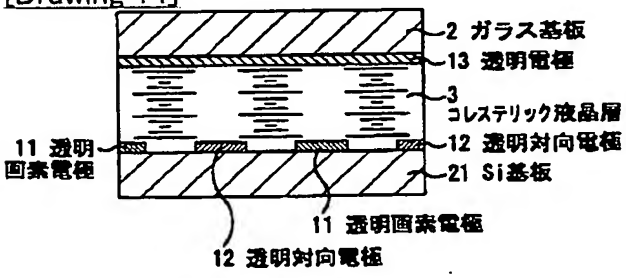
セル厚とピッチの比d/pとヒステリシス幅の関係

[Drawing 10]



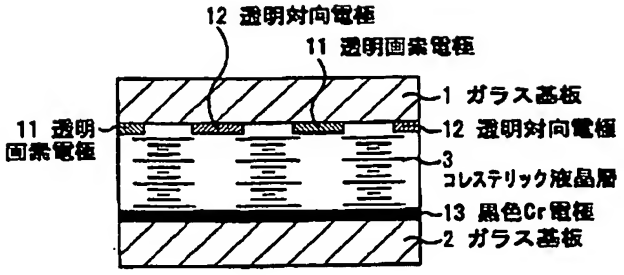
対向基板の電極有無とヒステリシスの関係(画素電極と対向電極の距離は4μm)

[Drawing 14]



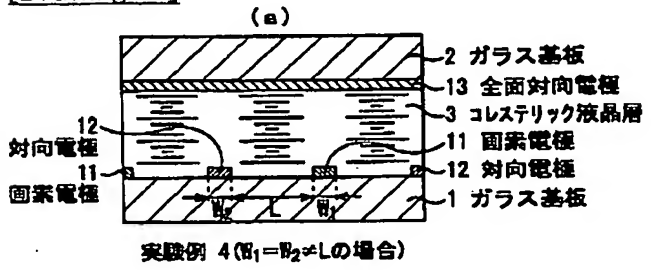
変形例 3

[Drawing 15]

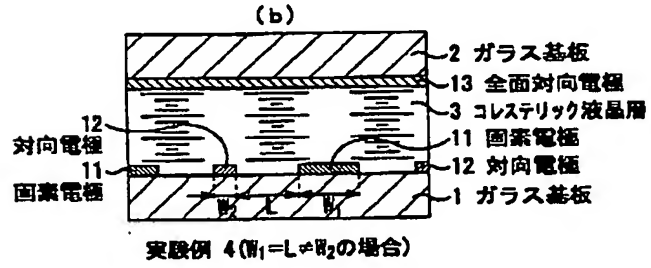


変形例 4

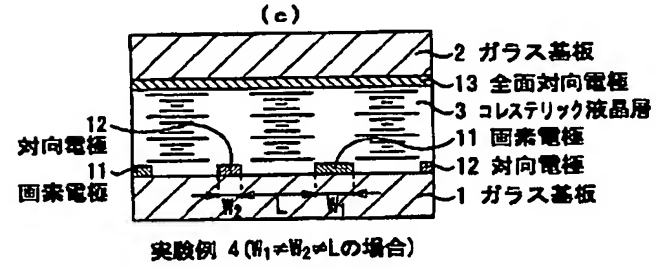
[Drawing 11]



実験例 4($W_1=W_2\neq L$の場合)

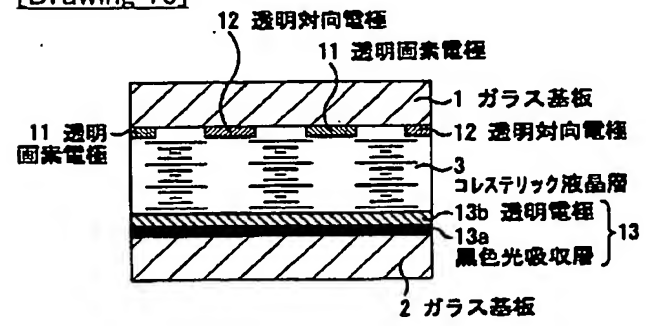


実験例 4($W_1=L\neq W_2$の場合)



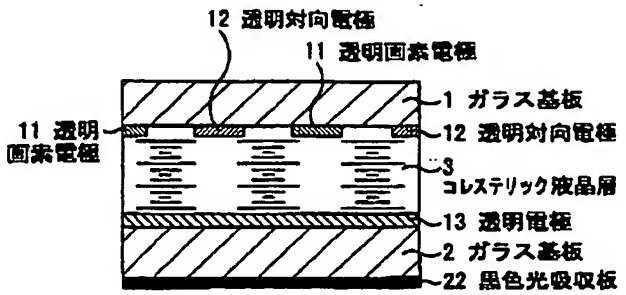
実験例 4($W_1\neq W_2\neq L$の場合)

[Drawing 16]



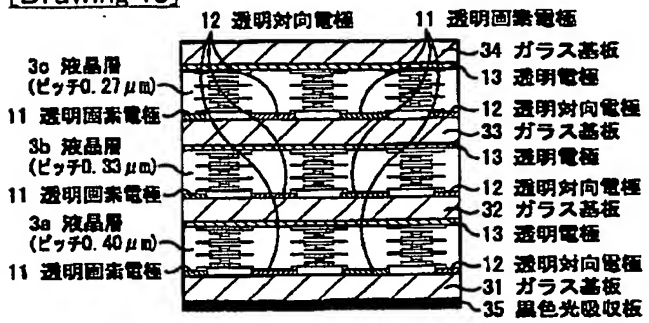
変形例 5

[Drawing 17]



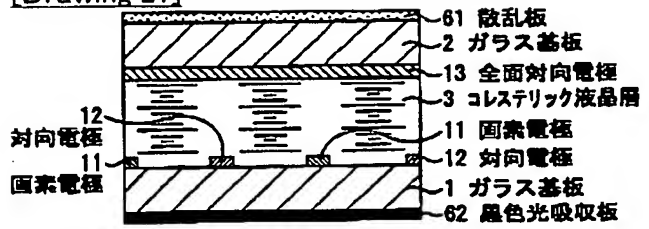
変形例 6

[Drawing 18]



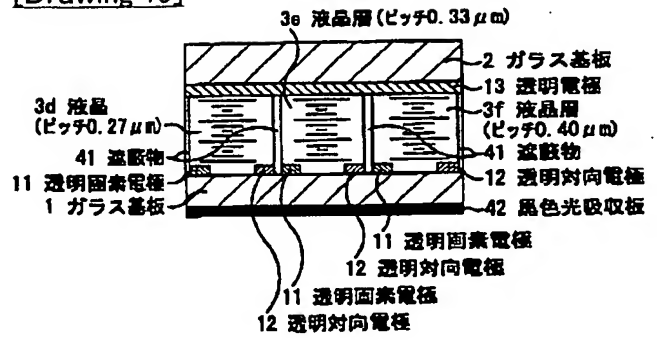
変形例 7

[Drawing 21]



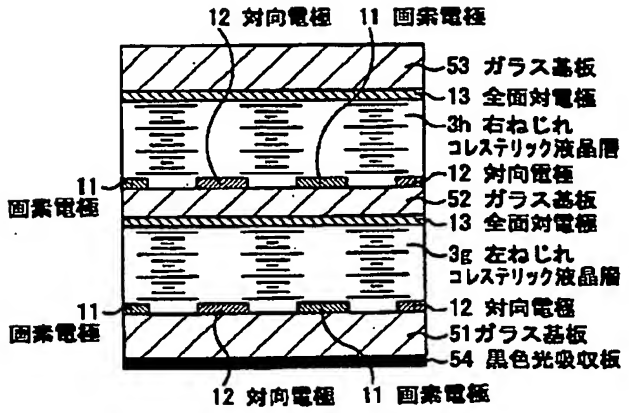
変形例 10

[Drawing 19]



変形例 8

[Drawing 20]



変形例 9

[Translation done.]

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特開2001－100256
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(51)Int.Cl.⁷	識別記号	ＦＩ		テーマコード（参考）
Ｇ０２Ｆ　1/139		Ｇ０２Ｆ　1/137	５０５	２Ｈ０８８
1/1365		1/136	５００	２Ｈ０９２

審査請求　未請求　請求項の数６　ＯＬ　（全 11 頁）

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(22)出願日　平成11年９月28日(1999.9.28)

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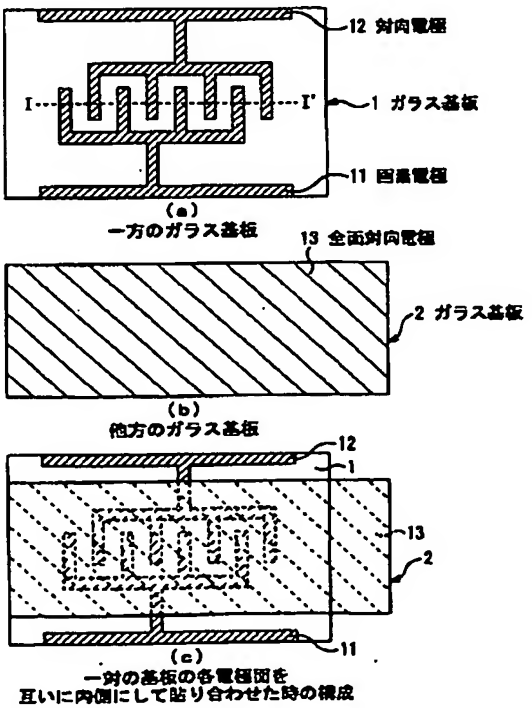
最終頁に続く

(54)【発明の名称】　液晶表示装置

(57)【要約】
【課題】　コレステリック液晶又はカイラルネマティック液晶からなる液晶層を備えた液晶表示装置について、ヒステリシスの発生を抑止し、低電圧による駆動を可能とする表示品位の高い液晶表示装置を提供する。
【解決手段】　表面に画素電極１１と対向電極１２が各々櫛歯形状にパターニングされ、互いに等間隔で対向するように併設されてなる基板１と、表面に全面対向電極が形成されてなる基板２とにより各電極が形成された面でコレステリック液晶又はカイラルネマティック液晶からなる液晶層３を挟持して液晶セルが構成される。



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【特許請求の範囲】

【請求項１】　対向する一対の基板間にコレステリック液晶又はカイラルネマティック液晶からなる液晶層を挟持してなる液晶表示装置であって、

一方の前記基板表面には各画素に対応した第１の電極が、他方の前記基板表面には第２の電極が前記液晶層を介して互いに対向するように配置されており、

前記第１の電極は、画素電極及び当該画素電極と同一面内で対向するように併設された対向電極を有して構成され、

前記画素電極と前記第２の電極との間に所定の電圧が印加されるとともに、前記画素電極と前記対向電極との間に所定の電圧が印加されることを特徴とする液晶表示装置。

【請求項２】　前記画素電極と前記対向電極との間の距離が６μｍ以下であり、且つ前記液晶層の厚みとねじれピッチとの比ｄ／ｐが１４以下であることを特徴とする請求項１に記載の液晶表示装置。

【請求項３】　前記液晶層の厚みが５μｍ以下であり、且つ前記液晶層の厚みとねじれピッチの比ｄ／ｐが２以下であることを特徴とする請求項１に記載の液晶表示装置。

【請求項４】　ねじれピッチの相異なる液晶からなる複数の前記液晶層が前記基板を介して積層されており、

前記各液晶層は、一方の面には前記第１の電極が配されるとともに、他方の面には前記第２の電極が配されてなることを特徴とする請求項１に記載の液晶表示装置。

【請求項５】　前記液晶層は、ねじれピッチの相異なる一組の液晶が各画素に対応するように遮蔽物で仕切られた領域に封入されてなり、前記一組の液晶に対応する画素群により絵素が構成されることを特徴とする請求項１に記載の液晶表示装置。

【請求項６】　ねじれ方向の相異なる液晶からなる２種の前記液晶層が前記基板を介して積層されており、

前記各液晶層は、一方の面には前記第１の電極が配されるとともに、他方の面には前記第２の電極が配されてなることを特徴とする請求項１に記載の液晶表示装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は液晶表示装置に関し、特にコレステリック液晶又はカイラルネマティック液晶からなる液晶層を備えた液晶表示装置に関する。

【０００２】

【従来の技術】一般に、コレステリック液晶は、そのねじれた分子配列に基づく性質として光散乱や選択反射等の様々な特徴を有している。このコレステリック液晶を用いた液晶表示装置の液晶セルとしては、図２２に示すように、表面にそれぞれ電極１０３，１０４を有する一対の基板１０１，１０２間にコレステリック液晶の液晶層１０５が挟持された構造を有するものがある。この液

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晶表示装置は、対向する電極１０３，１０４間に電圧を印加することで液晶層１０５の配向を変形させ、これにより画像表示を行う。表示方式には、散乱状態と透明状態を電圧で制御する方式や、赤色、緑色もしくは青色の光の選択反射状態と透明状態を電圧で制御する方式がある。いずれの方式でも、良好な表示特性を得るためには液晶層１０５のコレステリック液晶分子のねじれ角を大きくする必要がある。

【０００３】

【発明が解決しようとする課題】しかしながら、一般にコレステリック液晶を用いた液晶表示装置では、ねじれ角が３００°以上となることによりヒステリシスが発生する。このヒステリシスが存在する場合、電圧印加時の配向状態が電圧印加前の配向状態に依存するために良好な画像表示を得ることができないという問題がある。ねじれ角が大きくなるほどヒステリシスは増大する傾向にある。

【０００４】そこで本発明の目的は、コレステリック液晶又はカイラルネマティック液晶からなる液晶層を備えた液晶表示装置について、ヒステリシスの発生を抑止し、低電圧による駆動を可能とする表示品位の高い液晶表示装置を提供することである。

【０００５】

【課題を解決するための手段】本発明の液晶表示装置は、対向する一対の基板間にコレステリック液晶又はカイラルネマティック液晶からなる液晶層を挟持してなるものであって、一方の前記基板表面には各画素に対応した第１の電極が、他方の前記基板表面には第２の電極が前記液晶層を介して互いに対向するように配置されており、前記第１の電極は、画素電極及び当該画素電極と同一面内で対向するように併設された対向電極を有して構成され、前記画素電極と前記第２の電極との間に所定の電圧が印加されるとともに、前記画素電極と前記対向電極との間に所定の電圧が印加される。

【０００６】本発明の液晶表示装置の一態様において、前記画素電極と前記対向電極との間の距離が６μｍ以下であり、且つ前記液晶層の厚みとねじれピッチとの比ｄ／ｐが１４以下である。

【０００７】本発明の液晶表示装置の一態様において、前記液晶層の厚みとねじれピッチとの比ｄ／ｐが４以下である。

【０００８】本発明の液晶表示装置の一態様において、前記液晶層の厚みが５μｍ以下であり、且つ前記液晶層の厚みとねじれピッチの比ｄ／ｐが２以下である。

【０００９】本発明の液晶表示装置の一態様において、ねじれピッチの相異なる液晶からなる複数の前記液晶層が前記基板を介して積層されており、前記各液晶層は、一方の面には前記第１の電極が配されるとともに、他方の面には前記第２の電極が配されてなる。

【００１０】本発明の液晶表示装置の一態様において、

前記液晶層は、ねじれピッチの相異なる一組の液晶が各画素に対応するように遮蔽物で仕切られた領域に封入されてなり、前記一組の液晶に対応する画素群により絵素が構成される。

【００１１】本発明の液晶表示装置の一態様において、ねじれ方向の相異なる液晶からなる２種の前記液晶層が前記基板を介して積層されており、前記各液晶層は、一方の面には前記第１の電極が配されるとともに、他方の面には前記第２の電極が配されてなる。

【００１２】

【作用】本発明の液晶表示装置においては、一方の基板表面に第１の電極として画素電極及びこれと併設された対向電極が形成され、対向する他方の基板表面に第２の電極が設けられており、第１の電極の構成要素である画素電極と第２の電極との間に所定電圧を印加するとともに、画素電極と対向電極との間に所定電圧を印加する。即ち、一対の基板に挟持された液晶層には、厚み方向及びこれと直交する面内方向の各々に所定電圧による制御が行なわれるため、これら方向の異なる２種の電圧制御により効率的にヒステリシスの発生が抑止され、高品位の表示画像が実現する。

【００１３】

【発明の実施の形態】以下、本発明を適用した具体的な実施形態について図面を参照しながら詳細に説明する。図１は本実施形態の画像表示装置の主要構成を示す概略平面図であり、図２は図１の画像表示装置の破線Ｉ－Ｉ'に沿った概略断面図である。

【００１４】本実施形態の画像表示装置は、各々表面に電極が形成された一対のガラス基板１，２によりコレステリック液晶又はカイラルネマティック液晶からなる液晶層３を挟持されてなる液晶セルを備えて構成されている。

【００１５】ガラス基板１は、図１（ａ）に示すように、表面（ガラス基板２との対向面）に画素電極１１と対向電極１２とが併設されてなる第１の電極を有して構成されている。画素電極１１及び対向電極１２は、各々櫛歯形状にパターニングされ、互いに等間隔で対向するように形成されている。このように構成された第１の電極において、相対向する画素電極１１と対向電極１２の部位で１画素に相当し（即ち、図２の例では３画素に相当する画素電極１１が示されている。），各画素毎に不図示の薄膜トランジスタ（ＴＦＴ：Thin Film Transistor）が共に設けられることになる。

【００１６】他方、ガラス基板２は、図１（ｂ）に示すように、表面（ガラス基板１との対向面）の全面を覆うように第２の電極（全面対向電極１３）が形成されて構成されている。

【００１７】そして、図１（ｃ）及び図２に示すように、第１の電極と第２の電極を対向させるようにガラス基板１，２により液晶層３を挟み、各電極に所定の電源が接続されて画像表示装置が構成される。

【００１８】ここで、本実施形態の画像表示装置の動作原理について説明する。図３は、画像表示装置の各電極に電源Ｅからパルス電圧が印加される一例を示す概略断面図である。この画像表示装置には、対向電極１２と全面対向電極１３が同電位とされ、画素電極１１と全面対向電極１３との間及び画素電極１１と対向電極１２との間に所定電圧が印加される。

【００１９】上記の如く、液晶層３に厚み方向及びこれと直交する面内方向の各々に所定電圧を印加することにより、図４に示すように、画素電極１１上の液晶分子からねじれが解けてゆく。以下に示すように画素電極１１と対向電極１２との距離（電極間隙Ｌ）、液晶層３の厚みｄ、及び厚みｄとねじれピッチｐとの比（ｄ／ｐ）を適値に調節することにより、ヒステリシスが低減して安定した動作が得られる。

【００２０】－実験例－

具体的に、電圧透過率特性、電極間隙Ｌ、液晶層の厚みｄ及びｄ／ｐの値とヒステリシスとの相関関係を調べた諸実験例を示す。

【００２１】表面に画素電極１１及び対向電極１２が形成されたガラス基板１及び全面対向電極１３が形成されたガラス基板２の各表面に配向膜として、日本合成ゴム株式会社製の平行配向膜である商品名ＡＬ３０４６をスピンコートにより形成してラビング処理を施し、これらガラス基板１，２でコレステリック液晶（Merck 社製の液晶である商品名ＴＬ２０２に同社製のカイラル材である商品名ＣＢ－１５を混合してピッチを調節したもの）からなる液晶層３を挟持して液晶セルを作製する。当該液晶セルを形成するための前記各条件を総称して条件Ａとする。

【００２２】（実験例１）先ず、電圧透過率特性（Ｖ－Ｔ特性）を測定する。本例では、条件Ａに加え、画素電極１１及び対向電極１２について画素電極幅W_1、対向電極幅W_2及び電極間隙Ｌを図５のように定義した場合に、図６に示すように、画素電極幅W_1、対向電極幅W_2及び電極間隙Ｌの各値が等しくなるように形成されたガラス基板１を用い、ヒステリシスの変化が見えるように液晶に黒色色素を混入し、液晶層３の厚みを６μｍ、ｄ／ｐを２．２６となるように液晶セルを作製して、電圧透過率特性（Ｖ－Ｔ特性）を測定した。ここで、本例の比較例として、図２２に示すような従来の液晶セルを作成して同様に測定した。

【００２３】測定結果を図７に示す。このように、従来例では大きなヒステリシスが表れたが、それに対して本例では殆どヒステリシスが見られず、大幅なヒステリシスの低減が確認できた。

【００２４】（実験２）本例では、条件Ａに加え、画素電極１１及び対向電極１２が、画素電極幅W_1、対向電極幅W_2及び電極間隙Ｌの各値が等しくなるように形成

され、電極間隙Ｌが４μｍ、６μｍ、１０μｍ、１５μｍ、２５μｍとされた各ガラス基板１を用い、ｄ／ｐを変えてそれぞれ液晶セルを作製して、ｄ／ｐとヒステリシス幅との関係を調べた。但し、ヒステリシス幅をヒステリシスの最大幅として定義する。ここでも実験１と同様に、図２２に示すような従来の液晶セルを比較例とした。

【００２５】測定結果を図８に示す。ｄ／ｐの値が大きくなると、画素電極１１上の液晶分子がガラス基板１に対して垂直に変形し、複雑な配向変形を呈し始めるためにヒステリシスは大きくなる。具体的には、ｄ／ｐが１４以下であり且つ電極間隙Ｌが６μｍ以下の場合、または電極間隙Ｌによらずｄ／ｐが４以下の場合に従来例より小さいヒステリシスとなっていることが判る。特に、液晶層３の厚みｄが５μｍ以下であり且つｄ／ｐが２以下の場合に、ほとんどヒステリシスが発生していない結果が得られた。ヒステリシスの低減が確認できる電極間隙Ｌとｄ／ｐとの関係は、以下の表１に示すようになる。

【００２６】

【表１】

電極間隙Ｌ	ｄ／ｐ
４μｍ	１６以下
６μｍ	１４以下
１０μｍ	４以下
１５μｍ	４以下
２５μｍ	４以下

【００２７】なお、垂直配向膜を用いた液晶セルについても実験１，２と同様の測定を試みたところ、ヒステリシスの改善が見られた。

【００２８】（実験３）本例では、条件Ａに加え、画素電極１１及び対向電極１２が、画素電極幅W_1、対向電極幅W_2及び電極間隙Ｌの各値が等しくなるように形成されたガラス基板１を用い、電極間隙Ｌを４μｍとした液晶セル（セルａ）と、比較例として、図９に示すような前記液晶セルでガラス基板２に全面対向電極１３を有しない液晶セル（セルｂ）を用いた。これらの液晶セルを用いて電圧透過率特性を測定し、測定した電圧透過率特性から透過率がほぼ一定となる駆動電圧を求めた。

【００２９】測定結果を図１０に示す。このように、セルａはセルｂに比して遙かにヒステリシスが小さく、駆動電圧を低くできることが判る。

【００３０】（実験４）本例では、条件Ａに加え、画素電極１１及び対向電極１２が、画素電極幅W_1＝対向電極幅W_2≠電極間隙Ｌとなるように形成されたガラス基板１を用いた場合（図１１（ａ））、画素電極幅W_1＝電極間隙Ｌ≠対向電極幅W_2（画素電極幅W_2＝電極間隙Ｌ≠対向電極幅W_1でも同様）となるように形成されたガラス基板１を用いた場合（図１１（ｂ））、画素電極幅W_1、対向電極幅W_2及び電極間隙Ｌが何れも異なる値とされた場合（図１１（ｃ））の各々について実験１～３を行なった。その結果、何れの場合にもヒステリシスの改善が見られた。

【００３１】－変形例－

以下、本実施形態の画像表示装置の諸変形例について説明する。ここでは、本実施形態の画像表示装置と同様の構成部材等については同符号を記して説明を省略する。

【００３２】（変形例１）ここでは、図１２に示すように、画素電極１１及び対向電極１２の幅方向断面形状を突起状にした液晶セルを備えた画像表示装置を開示する。突起形状は図示のようなものだけに限らず、テーパー角を任意に選んだものや曲面で構成されたものが使用できる。この場合にも、本実施形態と同様にヒステリシスの大幅な改善が見られる。

【００３３】（変形例２）ここでは、図１３に示すように、画素電極１１及び対向電極１２がアルミニウム（Ａ１）から形成されてなるガラス基板１と、全面対向電極１３が透明電極（ＩＴＯ）で形成されてなるガラス基板２を用いてコレステリック液晶の液晶層３を挟持してなる液晶セルを備えた画像表示装置を開示する。この液晶セルを用いて画像表示特性を観察したところ、アルミニウム電極である画素電極１１及び対向電極１２で反射された光も有効に利用することができ、良好な表示を得ることができることを確認した。

【００３４】本例では、画素電極１１及び対向電極１２に共にアルミニウムを材料として用いたが、銀（Ａｇ）等の反射率が高い金属を用いること、または画素電極１１と対向電極１２で異なる金属を使うことも可能である。

【００３５】（変形例３）ここでは、図１４に示すように、画素電極１１及び対向電極１２が透明電極で形成されてなるシリコン基板２１と、全面対向電極１３が透明電極で形成されてなるガラス基板２とを用いてコレステリック液晶の液晶層３を挟持してなる液晶セルを備えた画像表示装置を開示する。この液晶セルを用いて画像表示特性を観察したところ、シリコン基板２１で反射された光も有効に利用することができ、良好な表示を得ることができることを確認した。

【００３６】（変形例４）ここでは、図１５に示すよう

に、画素電極１１及び対向電極１２が透明電極で形成されてなるガラス基板1-と、全面対向電極１３がＣｒ層で形成されてなるガラス基板２とを用いてコレステリック液晶の液晶層３を挟持してなる液晶セルを備えた画像表示装置を開示する。この液晶セルによれば、Ｃｒ層が光吸収層として機能し、Ｃｒ層に達した光は吸収されるために、良好な黒状態を得ることができる。

『００３７】（変形例５）ここでは、図１６に示すように、画素電極１１及び対向電極１２が透明電極で形成されてなるガラス基板１と、全面対向電極１３がＣｒ層である黒色光吸収層１３ａ及び透明電極１３ｂの積層構成とされてなるガラス基板２とを用いてコレステリック液晶の液晶層３を挟持してなる液晶セルを備えた画像表示装置を開示する。この液晶セルによれば、黒色光吸収層１３ａが光吸収層として機能し、黒色光吸収層１３ａに達した光は吸収されるために、良好な黒状態を得ることができる。

【００３８】（変形例６）ここでは、図１７に示すように、画素電極１１及び対向電極１２が透明電極で形成されてなるシリコン基板１と、全面対向電極１３が透明電極で形成されてなるガラス基板２とを用いてコレステリック液晶の液晶層３を挟持してなる液晶セルを構成し、液晶セルの背面に黒色光吸収板２２を貼り合わせてなる画像表示装置を開示する。この液晶セルによれば、黒色光吸収板２２に達した光は吸収されるために、良好な黒状態を得ることができる。

【００３９】（変形例７）ここでは、図１８に示すように、ねじれピッチの相異なる液晶からなる３層の液晶層３ａ，３ｂ，３ｃを、ガラス基板３１～３４を介してそれぞれ挟持してなる各液晶セルを備えた画像表示装置を開示する。この液晶セルにおいては、各液晶層３ａ，３ｂ，３ｃの一方の面には第１の電極（画素電極１１及び対向電極１２）が、他方の面には第２の電極（全面対向電極１３）が存するように、ガラス基板３１～３４に各電極が形成されている。即ち、ガラス基板３１の一方の表面（液晶層３ａ側）には第１の電極、ガラス基板３４の一方の表面（液晶層３ｃ側）には第２の電極、ガラス基板３２，３３の一方の表面には第１の電極、他方の表面には第２の電極が形成されている。そして、積層された液晶セルの下部（ガラス基板３１の他方の表面）に黒色光吸収板３５として偏光軸を直交させた２枚の偏光子が貼り合わされる。

【００４０】具体的には、各電極１１～１３を透明電極から形成し、画素電極幅W_1、対向電極幅W_2及び電極間隙Ｌの各値が等しくなるように形成されたガラス基板３１～３４を用い、ねじれピッチが０．４０μｍ、０．３３μｍ、０．２７μｍであるコレステリック液晶（Merck 社製の液晶である商品名ＴＬ２０２に同社製のカイラル材である商品名ＣＢ－１５を混合してねじれピッチを調節したもの）からなる液晶層３ａ，３ｂ，３ｃをそれぞれ挟持して各液晶セルを作製し、それらを積層する。

【００４１】それぞれの液晶セルを電圧で駆動させることで黒、白、赤、緑、青、黄、紫、水色の８色が得られることを確認できた。この場合、液晶層３ａ，３ｂ，３ｃを備えた各液晶セルは、それぞれ青、緑及び赤の光を選択反射することができ、それぞれ０．２５μｍ～０．３０μｍ、０．３１μｍ～０．３６μｍ、０．３８μｍ～０．４４μｍの範囲であれば目視による大幅な色変化が見られなかった。

【００４２】（変形例８）ここでは、図１９に示すように、画素電極１１、対向電極１２及び全面対向電極１３をそれぞれ透明電極から形成してなるガラス基板１，２を用い、当該ガラス基板１，２間にねじれピッチの相異なる液晶分子からなる３種の液晶層３ｄ，３ｅ，３ｆが繰り返し設けられて液晶セルを構成し、セル背面に黒色光吸収板４２を貼り合わせてなる画像表示装置を開示する。この液晶セルにおいては、液晶の混合を防止するための遮蔽物４１で仕切られた領域に前記各液晶が封入され、各画素毎に対応して液晶層３ｄ，３ｅ，３ｆの一つが設けられる。この場合、絵素は、液晶層３ｄ，３ｅ，３ｆに対応した一組の画素群から構成され、それぞれの画素に対応した液晶層を電圧駆動させることで黒、白、赤、緑、青、黄、紫、水色の８色が得られる。

【００４３】具体的には、各電極１１～１３を透明電極から形成し、画素電極幅W_1、対向電極幅W_2及び電極間隙Ｌの各値が等しくなるように形成されたガラス基板１，２を用い、ねじれピッチが０．２７μｍ，０．３３μｍ、０．４０μｍであるコレステリック液晶からなる液晶層３ｄ，３ｅ，３ｆを各画素毎に配して液晶セルを作製する。

【００４４】（変形例９）ここでは、図２０に示すように、ねじれ方向の相異なる、即ち、左ねじれの液晶からなる液晶層３ｇと右ねじれの液晶からなる液晶層３ｈを、ガラス基板５１～５３を介してそれぞれ挟持してなる各液晶セルを備えた画像表示装置を開示する。この液晶セルにおいては、各液晶層３ｇ，３ｈの一方の面には第１の電極（画素電極１１及び対向電極１２）が、他方の面には第２の電極（全面対向電極１３）が存するように、ガラス基板５１～５３に各電極が形成されている。即ち、ガラス基板５１の一方の表面には第１の電極、ガラス基板５３の一方の表面には第２の電極、ガラス基板５２の一方の表面には第１の電極、他方の表面には第２の電極が形成されている。そして、積層された液晶セルの背面に黒色光吸収板５４が貼り合わされる。

【００４５】具体的には、右ねじれコレステリック液晶としてMerck 社製の液晶である商品名ＴＬ２０２に同社製のカイラル材である商品名ＣＢ－１５を混合したものと、左ねじれのコレステリック液晶としてMerck 社製の液晶である商品名ＴＬ２０２に同社製のカイラル材であ

る商品名Ｙｓを添加したものを積層し、いずれも緑色の選択反射光が得られるようにねじれピッチを０．３４μｍに調節した。積層した液晶パネルを観察した結果、単層の液晶パネルに比して明るい表示が得られることを確認した。

【００４６】（変形例１０）図２１に示すように、図２に例示する本実施形態と同様の液晶パネルを用い、前面に前方散乱板６１、背面に黒色光吸収板６２が貼り合わされてなる画像表示装置を例示する。この液晶パネルの表示画像を観察した結果、電圧を変化させた場合に前方散乱板６１が無い場合よりも良好なコントラストが得られることを確認した。

【００４７】以下に示す諸態様もまた本発明を構成する。

【００４８】液晶表示装置の一態様であって、ねじれピッチが０．２５μｍ～０．４４μｍであることを特徴とする。

【００４９】液晶表示装置の一態様であって、前記画素電極の電極幅又は対向電極の電極幅と、前記画素電極と前記対向電極との距離が異なることを特徴とする。

【００５０】液晶表示装置の一態様であって、前記画素電極の幅と前記対向電極の幅が異なることを特徴とする。

【００５１】液晶表示装置の一態様であって、前記画素電極及び前記対向電極の各断面形状が突起状とされていることを特徴とする。

【００５２】液晶表示装置の一態様であって、前記各基板の一方の前記電極が金属で形成されていることを特徴とする。

【００５３】液晶表示装置の一態様であって、前記画素電極と前記対向電極が異なる金属で形成されていることを特徴とする。

【００５４】液晶表示装置の一態様であって、前記各基板の一方が光反射機能を有することを特徴とする。

【００５５】液晶表示装置の一態様であって、前記各基板の一方が光吸収機能を有することを特徴とする。

【００５６】液晶表示装置の一態様であって、前記各基板の一方について、前記電極と当該基板との間に光吸収層が形成されていることを特徴とする。

【００５７】液晶表示装置の一態様であって、前記各基板の一方に光吸収層が外付されていることを特徴とする。

【００５８】液晶表示装置の一態様であって、前記各基板の一方に散乱板が貼り付けられていることを特徴とする。

【００５９】

【発明の効果】本発明によれば、コレステリック液晶又はカイラルネマティック液晶からなる液晶層を備えた液晶表示装置について、ヒステリシスの発生を抑止し、低電圧による駆動を可能とする表示品位の高い液晶表示装置が実現する。

【図面の簡単な説明】

【図１】本実施形態の画像表示装置の主要構成を示す概略平面図である。

【図２】本実施形態の画像表示装置の主要構成を示す概略断面図である。

【図３】本実施形態の画像表示装置の各電極にパルス電圧が印加される一例を示す概略断面図である。

【図４】本実施形態の画像表示装置の動作原理を説明するための概略断面図である。

【図５】画素電極及び対向電極について、画素電極幅W_1、対向電極幅W_2及び電極間隙Ｌを定義する概略断面図である。

【図６】実験例１の画像表示装置の主要構成を示す概略断面図である。

【図７】電圧透過率特性（Ｖ－Ｔ特性）の測定結果を示す特性図である。

【図８】液晶層の厚みｄとねじれピッチｐとの比（ｄ／ｐ）とヒステリシス幅との関係を示す特性図である。

【図９】全面対向電極を有しない液晶セルを示す概略断面図である。

【図１０】液晶層の厚みｄとねじれピッチｐとの比（ｄ／ｐ）とヒステリシス幅との関係を示す特性図である。

【図１１】画素電極幅W_1、対向電極幅W_2、電極間隙Ｌの関係を変えた種々の液晶セルを示す概略断面図である。

【図１２】変形例１の画像表示装置の主要構成を示す概略断面図である。

【図１３】変形例２の画像表示装置の主要構成を示す概略断面図である。

【図１４】変形例３の画像表示装置の主要構成を示す概略断面図である。

【図１５】変形例４の画像表示装置の主要構成を示す概略断面図である。

【図１６】変形例５の画像表示装置の主要構成を示す概略断面図である。

【図１７】変形例６の画像表示装置の主要構成を示す概略断面図である。

【図１８】変形例７の画像表示装置の主要構成を示す概略断面図である。

【図１９】変形例８の画像表示装置の主要構成を示す概略断面図である。

【図２０】変形例９の画像表示装置の主要構成を示す概略断面図である。

【図２１】変形例１０の画像表示装置の主要構成を示す概略断面図である。

【図２２】従来の画像表示装置の主要構成を示す概略断面図である。

【符号の説明】

１，２，３１～３４，５１～５３　ガラス基板

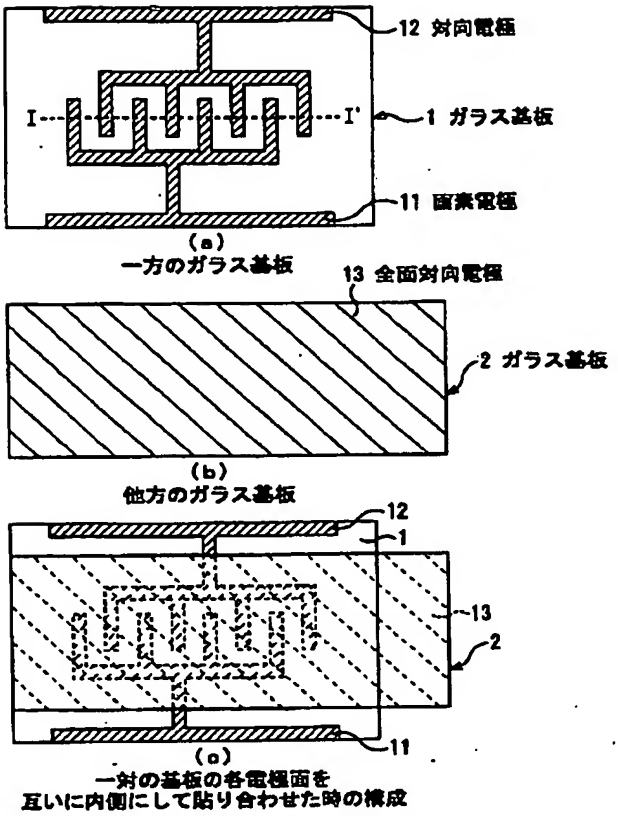
11

3，3a～3h　液晶層
11　画素電極
12　対向電極
13　全面対向電極

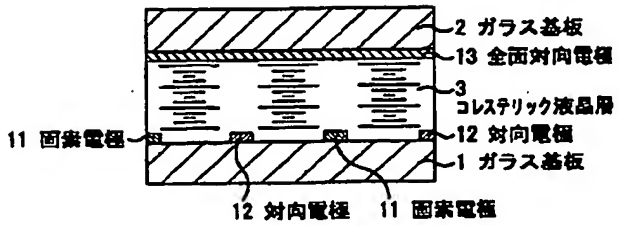
12

＊21　シリコン基板
22，35，42，54，62　黒色光吸収板
41　遮蔽物
＊　61　前方散乱板

【図1】

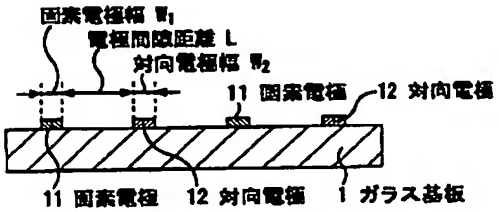


【図2】



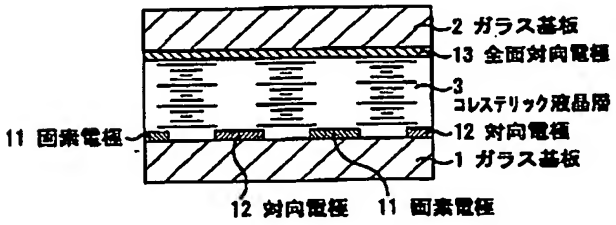
本実施形態の液晶セル

【図5】



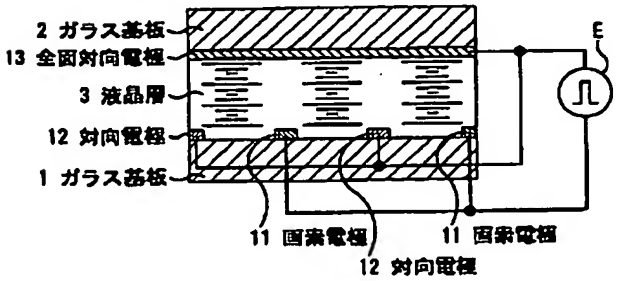
基板表面に画素電極および対向電極を形成したガラス基板

【図6】



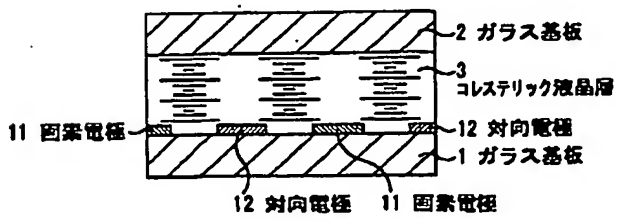
実験例 1

【図3】



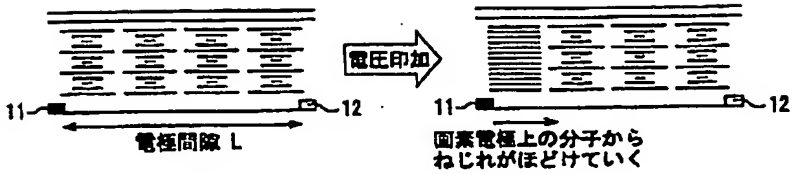
駆動例

【図9】

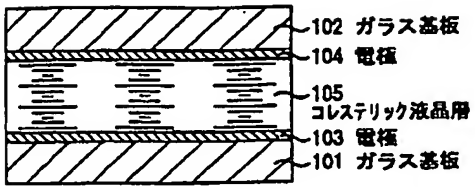


実験例 3

【図４】

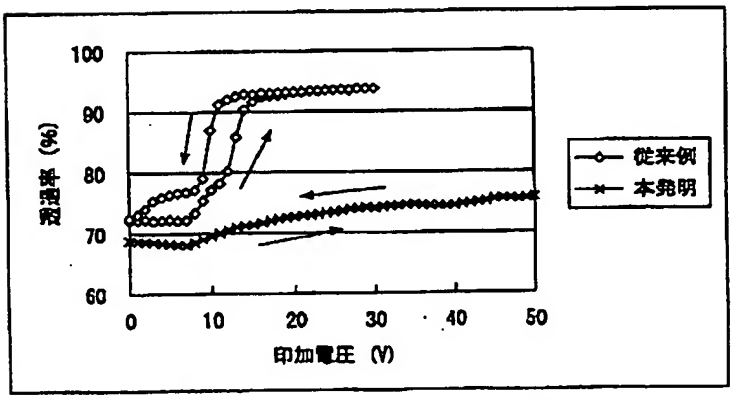


【図２２】



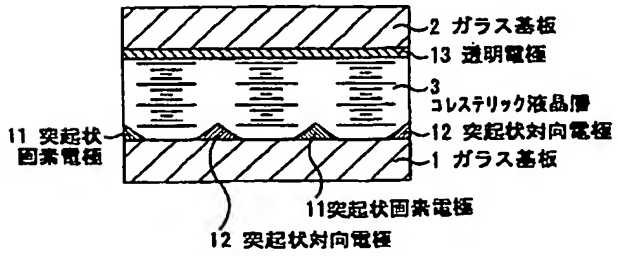
従来例

【図７】



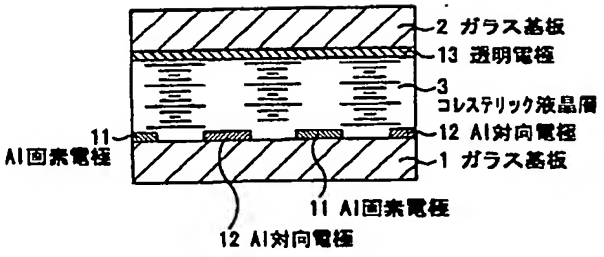
電圧透過率特性(セル厚6μm、d／p=2.26)

【図１２】



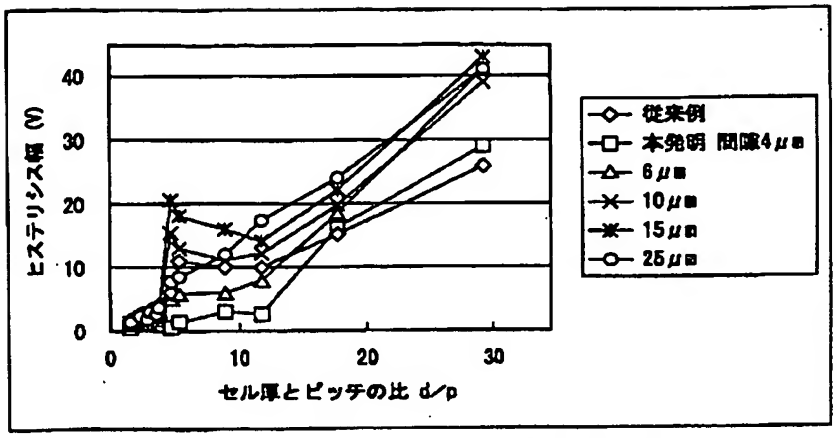
変形例 1

【図１３】



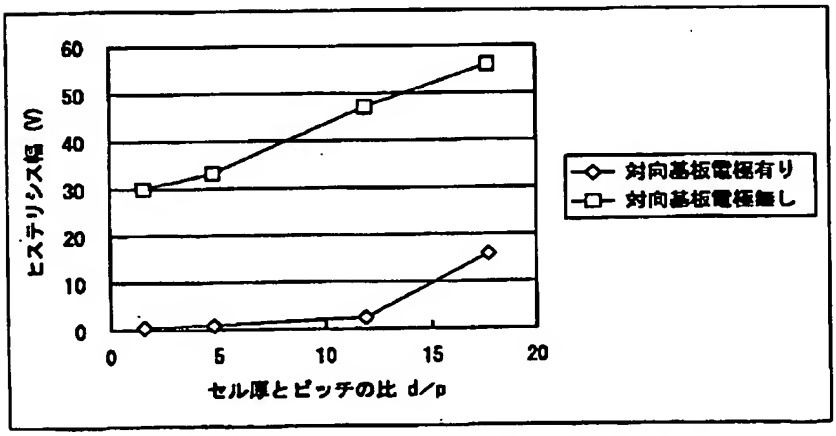
変形例 2

【図８】



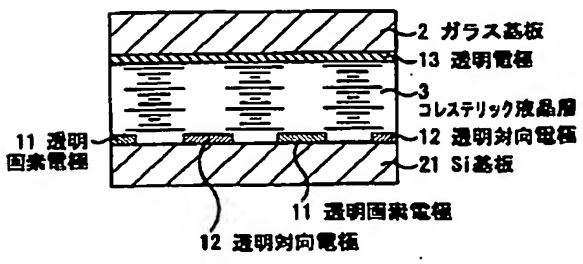
セル厚とピッチの比d/pとヒステリシス幅の関係

【図１０】



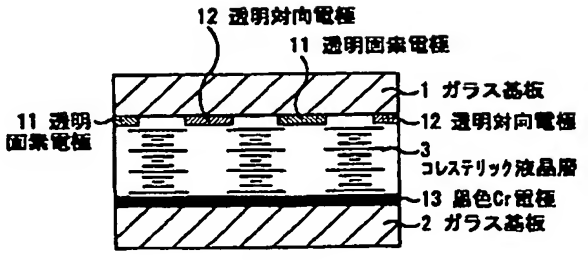
対向基板の電極有無とヒステリシスの関係(画素電極と対向電極の距離は4μm)

【図１４】



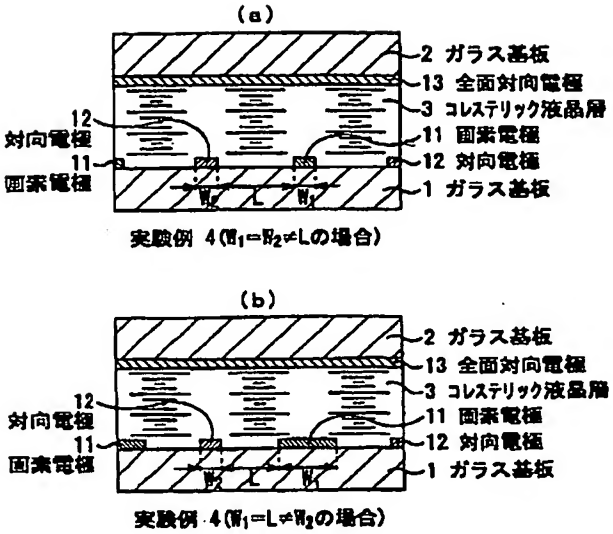
変形例 3

【図１５】



変形例 4

【図１１】

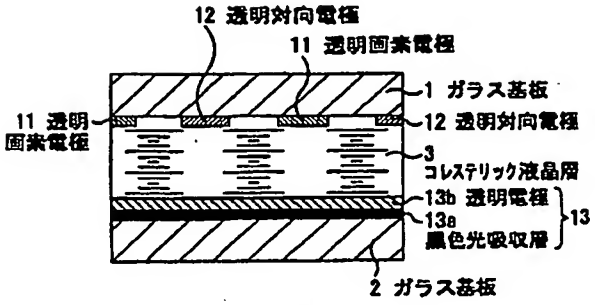


実施例 4($W_1=W_2\neq L$の場合)

実施例 4($W_1=L\neq W_2$の場合)

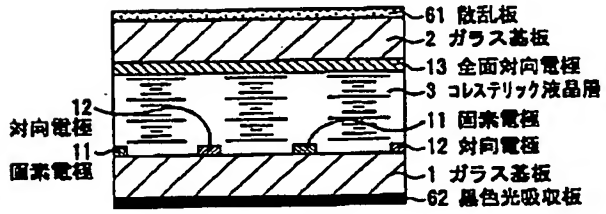
実施例 4($W_1\neq W_2\neq L$の場合)

【図１６】



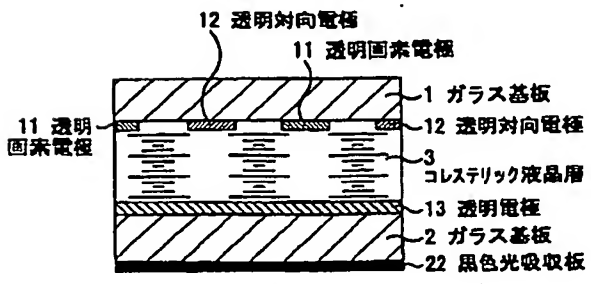
変形例 5

【図２１】



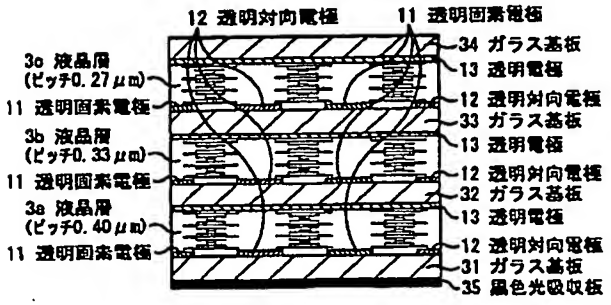
変形例 10

【図１７】



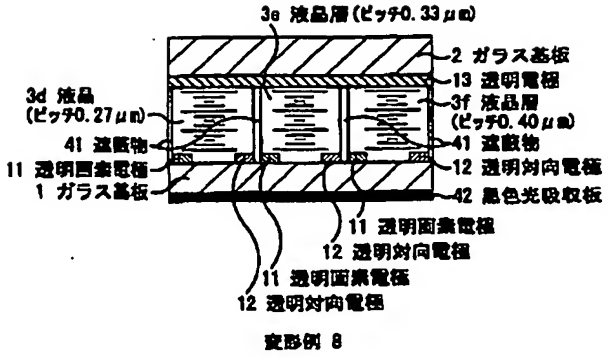
変形例 6

【図１８】



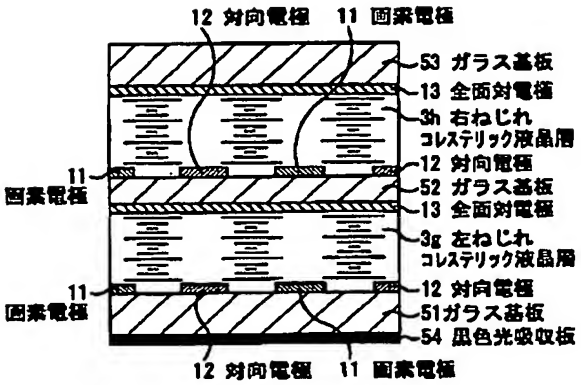
変形例 7

【図１９】



変形例 8

【図２０】



変形例 9

フロントページの続き

Ｆターム(参考)　2H088 GA02 GA03 GA17 HA08 HA14
JA13 KA12 MA02 MA20
2H092 GA13 JA24 NA25 PA09 QA10